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Review Paper on Cognitive Radio Networks based on Spectrum Sensing Technique

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ABSTRACT: A cognitive radio (CR) has intelligence to learn from its environment and adapt by modifying its parameters to improve spectrum utilization while providing reliable communication. Cognitive radio technology has the ability to find spectrum holes by spectrum sensing and accessing them efficiently. Spectrum sensing, which enables CRs to identify spectrum holes, is an important part of CR technology. It is the process of periodically and dynamically monitoring a given radio spectrum band, in order to determine its availability for use on a non-interfering basis. The aim of cognitive radio is to obtain the best available spectrum through cognitive capability and configurability which involves spectrum sensing, analysis, decision and adaptation. The challenging factor is to combine the Non-cooperative communication in cognitive radio to improve the spectral efficiency and to reduce the BER factor of unlicensed user's communication. In this paper, a comparative study of different communication techniques are done by considering Rayleigh fading channel environment and the advantages of non-cooperative communication is analyzed.

KEYWORDS: OFDM System, MIMO-OFDM, Cognitive Radio, Non-Cooperative Communication

I. INTRODUCTION

Cognitive radio has secured an important place in the highly researched paradigms in wireless communication systems. This is by virtue of its ability to increase spectrum efficiency and network capacity. The overall network capacity is increased by interference-free sharing of spectrum among multiple wireless communication systems. CR enables users to access multiple air interfaces and select the most suitable alternatives based on the operational conditions and communication needs. Adoption of CR techniques has been beneficial to many wireless communication systems [1, 2]. CR techniques are introduced into mobile and satellite communication networks. The background, reasons for the adoption and details of the techniques are discussed at length in [3]. It provides an outline of how the CR technology is adopted in various other wireless communication systems such as public safety and emergency networks, Internet of Things based on wireless communication, military communications and aeronautical communications. Spectrum sensing is the building block of cognitive radio. It is the process of identifying the spectrum usage and determining if the primary users exist in a given geographical area. In CR, spectrum sensing is not only about measuring the RF energy over the spectrum but it becomes a more general term that encompasses obtaining characteristics of spectrum usage across dimensions such as space, time, frequency and code. The opportunistic spectrum access and cognitive radio concepts have added new dimensions to spectrum sensing and undoubtedly, it is one of the key challenges to be dealt with in cognitive radio systems [4]. The main challenges associated with spectrum sensing are noise uncertainty conditions, availability of suitable hardware platforms, hidden primary user, sensing duration and frequency and detecting spread spectrum primary users. Reduction in cooperative overheads and decision fusion strategy are the main challenges in cooperative sensing [5].

II. LITERATURE REVIEW

Arun Kumar et al. [1], cognitive radio systems are made possible by spectrum sensing, which enables the identification and utilization of underutilized frequency bands. Convolutional brain organizations (CNNs) and repetitive brain organizations (RNNs), specifically, have showed guarantee as of late for improving the accuracy and adequacy of range detecting. An overview of the capabilities of CNNs and RNNs for spectrum sensing in cognitive

radio systems is provided in this paper. The paper also examines RNNs' spectrum sensing capabilities, particularly when processing time-series data. RNNs are essential for spectrum sensing tasks in which signals change over time because they are able to recognize temporal dependencies in sequential data. For the purposes of spectrum sensing algorithms, the parakeets' probability of detection (Pd), probability of false alarm (PFA), bit error rate (BER), and power spectral density (PSD) are also examined. Deep learning (DLM) techniques like RNNs and CNNs performed better than more conventional approaches.

Kumar et al. [2], more range groups are required as the quantity of remote applications rises. However, it is now extremely challenging to adapt the spectrum band to new applications. The spectrum is becoming more congested as a result, which also has an effect on the quality of service (QoS). Cognitive radio (CR) is one of the most promising technologies for dealing with the problem of limited spectrum. It is believed that spectrum sensing (SS) is necessary for CR. It determines whether the spectrum can be allocated to secondary users (SUs) when primary users (PUs) are not using it. A hybrid matched filter (HMF) algorithm based on the fusion of two matched filters (MF) was used to implement a novel 5G spectrum sensing method in this paper. Additionally, we compared how well the HMF and conventional MF performed in Rayleigh and Rician channels. In both channels, it has been observed that the HMF performs better than the conventional MF.

Arun Kumar et al. [3], due to its ability to effectively detect idle spectrum with low signal-to-noise ratios (SNR), the cyclostationary spectrum (CS) method is one of the best at what it does. CS achieves optimal performance characteristics by employing spectral correlation for dependable framework modeling, collecting more data to improve signal analysis, and separating the signal from noise. Considered to be one of the CS's drawbacks is its high intricacy. For 5G waveforms, we propose a novel CS algorithm in this article. By confining the calculation of cyclostationary qualities and the sign autocorrelation, the intricacy of CS is decreased. The Cognitive Radio (CR)-based Energy Detection (ED) and CS spectrum sensing algorithms are presented to evaluate the performance of 5G waveforms. The study found that the proposed CS algorithm outperformed the conventional standards in terms of detection performance by 2 dB.

Shen et al. [4], range planning has arisen as a significant issue in remote correspondences, which produces a range map for the range asset examination and the executives. A pressing challenge for spectrum mapping is how to effectively reconstruct the situation using the limited sampling data, given the constrained transceiver volume and limited energy consumption. Using compressed sensing, we first try to solve the three-dimensional (3D) compressed spectrum mapping problem in this paper by taking advantage of the sparse nature of the situation. Then, at that point, we foster a quadrature and right-three-sided (QR) turning based estimation lattice improvement calculation. By iteratively choosing new prevailing testing areas, it advances the recuperation precision contrasted with arbitrary estimation. For 3D compressed spectrum mapping, we then propose an orthogonal matching pursuit (OMP) algorithm based on 3D spatial subspace to recover the spectrum situation. At long last, reproductions are introduced to show the examinations as far as confinement, source signal strength recuperation, recuperation achievement rate and circumstance recuperation. Our proposed 3D spectrum mapping method achieves a high level of spectrum mapping accuracy while effectively reducing the sampling number, as demonstrated by the results.

Hamedani et al. [5], this article presents a clever energy proficient range detecting strategy for numerous information various result and symmetrical recurrence division multiplexing (MIMO-OFDM) frameworks in powerful range sharing (DSS) conditions. In order to take advantage of the environment's spatial and temporal correlations, a spiking reservoir computing (RC)-based method is used for spectrum sensing in MIMO-OFDM systems. A spiking delayed feedback reservoir (DFR) is one thing we create. DFRs are another class of repetitive brain organizations (RNNs) which tackle the evaporating slope issue of conventional RNNs while spiking neurons are energy productive and organically conceivable neuron models. We broaden our presented model in existence spaces to catch the spatial and transient relationships in DSS conditions. Restrictive generative antagonistic organizations (cGANs) are acquainted with tackle the information shortage issue emerged from applying AI procedures to MIMO-OFDM frameworks where it is restricted to prepare information. According to simulation results, the introduced RC-based spectrum sensing has a significantly higher probability of detection at low signal-to-noise (SNR) levels than the most recent methods, and its computational complexity is also lower than that of conventional RNNs.

Arun Kumar et al. [6], in Symmetrical Recurrence Division Multiplexing OFDM, a cyclic prefix (CP) is applied to decrease the mediation between images. The cognitive radio is the answer to the problem of wasted bandwidth caused by the CP. OFDM with CP is demonstrated and integrated with cyclostationary spectrum sensing in the first section of the work. Following this, OFDM with cyclostationary spectrum sensing and no CP is proposed. The filter at the transmitter and receiver is designed to make use of the bandwidth lost during the CP phase. The Piece Mistake Rate BER, signal likelihood recognition, misleading problem, and blunder likelihood are acquired and investigated.

Abdullah Yaqot et al. [7], through this paper, an endeavor has been made to further develop the energy proficiency of the asset portion process for Symmetrical Recurrence Division Multiplexing (OFDM)- based mental radio (CR) networks with blemished range detecting. Augmenting the energy productivity of the multi-client CR framework is the principal objective, while at the same time sticking to the complete transmission power limitation alongside every Essential Client's (PU) impedance imperative, and furthermore guaranteeing that the limit of the framework stays as high as could really be expected. The blunders in range detecting have been considered, and afterward, the obstruction model is figured out. Windowing has been implemented to lessen the interference that PUs suffer from. A mixed-integer nonlinear programming problem arises during the process of allocating resources. Since sub-carrier assignment and power allocation are the two steps in the resource allocation scheme, the proposed algorithm provides a suboptimal solution. Prior to allocating power, sub-carrier assignment is carried out. The power allocation process makes use of the sub-gradient method and the fractal programming approach. When compared to the methods that were used before, the results of the simulation demonstrate that there is a rise in energy efficiency. The PU's normal communication can also be safeguarded by accounting for sensing errors. Windowing technique utilized for diminishing the impedance, thusly, expands the limit of the framework.

Danda B. Rawat et al. [8], have proposed the performance of cognitive radio (CR) in MIMO-OFDM system with the help of cyclostationary spectrum sensing. CR devices continuously sense the channel to check whether it is idle or not using spectrum sensing detection. There are two types of channel assign in cyclostationary spectrum sensing i.e. primary and secondary spectrum sensing. Primary spectrum sensing is a sensing to sense the licensed users and secondary spectrum sensing is a sensing to sense the not licensed users. It is calculate the mean square error (MSE), successful reconstruction rate (SRR) and probability.

Shan Jin et al. [9], the WiMAX (worldwide Interoperability for Microwaves get entry to) is a promising generation that can provide excessive velocity voice, video and facts provider as much as the patron cease. The improvement of 802.sixteen requirements for BWA (Broadband wireless access) technologies turned into prompted through the rapidly growing need for excessive-speed, ubiquitous and price powerful get right of entry to. The WiMAX also can be taken into consideration to be the principle era within the implementation of other networks like wireless sensor networks. Growing an expertise of the WiMAX device can be first-class performed via looking at a model of the WiMAX device. This paper discusses the version building of the WiMAX bodily layer using Simulink in MATLAB R2009a model. This model is a beneficial device for BER (Bit mistakes fee) overall performance assessment for the actual time audio facts communiqué by using the WiMAX physical layer, below exclusive channel encoding price, and virtual modulation schemes and channel situations, except serving as a helpful resource for the scholars and the researchers who need to base their studies and research in the subject of WiMAX. On this paper, transmitter and receiver version are simulated consistent with the parameters set up by using the standards, to assess the overall performance. Additionally convolution coding is used to enhance the system overall performance. The performance analysis is being completed via reading the bit loss and packet losses happened all through transmission over the channel.

Maan Singh et al. [10], the real and imaginary parts of complex factor corresponding to in-phase components and quadrature components of OFDM symbols, respectively. It is to be noted that in ideal cases, the demodulation is performed based on the assumption of perfect symbol timing, carrier frequency, and phase synchronization. This is usually not practically possible to achieve; therefore, the demodulated signal will not be the exact replica of input signal; resulting in bit error rate (BER). The term BER can be mathematically expressed as the difference of the received demodulated data and the input data.

III. SPECTRUM SENSING

A noteworthy test in psychological radio is that the auxiliary clients need to identify the nearness of essential clients in an authorized range and quit the recurrence band as fast as could be expected under the circumstances if the relating essential radio rises so as to stay away from impedance to essential clients. This procedure is called range detecting. Range detecting and estimation is the initial step to execute Cognitive Radio framework [5]. We can sort range detecting systems into direct technique, which is considered as recurrence space approach, where the estimation is done straightforwardly from flag and backhanded strategy, which is known as time area approach, where the estimation is performed utilizing autocorrelation of the flag. Another method for ordering the range detecting and estimation techniques is by making bunch into model based parametric strategy and period gram based nonparametric technique.

a. Essential transmitter discovery: For this situation, the identification of essential clients is performed dependent on the got flag at CR clients. This methodology incorporates coordinated channel (MF) based location, vitality based recognition, covariance based discovery, waveform based location, cyclostationary based recognition, radio recognizable proof based identification and irregular Hough Transform based location.

b. Agreeable and synergistic location: In this methodology, the essential signs for range openings are recognized dependably by communicating or participating with different clients, and the technique can be executed as either brought together access to range facilitated by a range server or conveyed approach inferred by the range stack smoothing calculation or outside identification.

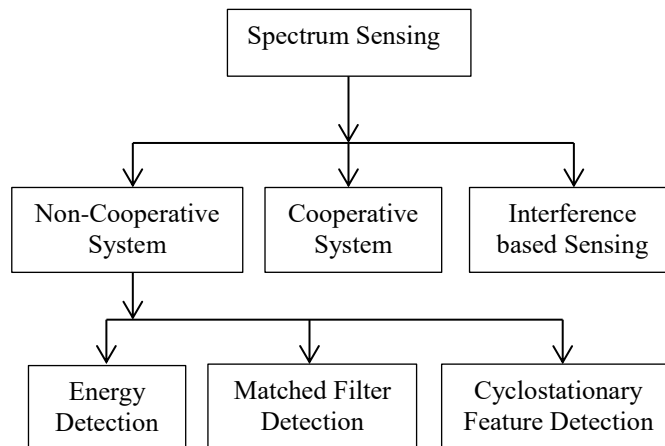


Fig. 1: Classification of spectrum sensing techniques

Figure 1 shows the detailed classification of spectrum Sensing techniques. They are broadly classified into three main types, transmitter detection or non-cooperative sensing, cooperative sensing and interference based sensing. Transmitter detection technique is further classified into energy detection, matched filter detection and cyclostationary feature detection [12].

Non-cooperative Spectrum Sensing

Since it is difficult to sense the status of the primary receiver, so to detect the primary user transmission it is necessary to detect the signals sent by the primary transmitter. This kind of spectrum sensing is also called primary transmitter detection.

Energy Detection

If CR users have no information about the primary signals then energy detection can be used for spectrum sensing. ED is optimal detector if noise power is known to the CR user [2]. Energy detection is very simple and easy to implement. It is the most popular spectrum sensing technique. In energy detection, the presence of the signal is detected by measuring the signal over an observation time.

Advantages: Simple and fewer complexes than other techniques No prior knowledge of the primary signal required

Easy to implement

Disadvantages: High sensing time required to achieve the desired probability of detection Using ED, it is not easy to distinguish Primary Signal from noise signal Detection performance is limited by noise uncertainty Spread spectrum signals cannot be detected by ED.

Matched Filter

Detection In matched filter detection SNR of the received signal is maximized. The CR user needs to have the prior knowledge of the primary signal transmitted by the primary user. This is the basic requirement for the matched filter detection. Matched filter operation defines a correlation in which unknown signal is convolved with the filter whose impulse response is the mirror and time shifted versions of a reference signal [6].

Advantages: It needs less detection time. When information of the primary user signal is known to the CR user then Matched Filter Detector is optimal detector in stationary Gaussian noise [3].

Disadvantages: It needs priori knowledge of the received signal. High Complexity.

Cyclostationary Feature Detection

The modulated signals are generally cyclostationary in nature and this kind of feature of these signals can be used in this technique to detect the signal. A cyclostationary signals have the statistical properties that vary periodically with time [7]. This periodicity is used to identify the presence or absence of primary users. Due to the periodicity, these cyclostationary signals exhibit the features of periodic statistics and spectral correlation, which is not found in stationary noise [8].

Advantages: Robust to noise uncertainties and better performance in low SNR regions. Capable of distinguishing the CR transmissions from various types of PU signals. No synchronization required Improves the overall CR throughput

Disadvantages: Highly complex method long sensing time

IV. METHODOLOGY

The circuit will be implementations in MATLAB 2013b software, with the main parameters described below. We generated a random binary signal generate in a serial manner. To analyze a signal in the time domain, we apply IFFT (Inverse Fast Fourier Transform) and convert it from parallel to serial OFDM signal to add a cyclic prefix (CP), which helps avoids interference between OFDM symbols.

This signal is then feed through an Additive White Gaussian Noise (AWGN) channel. At the receiver end, the CP is removed and the signal converted from serial to parallel to get the original, with FFT applied to each symbol for analysis in the frequency domain. After demodulation, the signal is cross correlated with that of a time-shifted local oscillator.

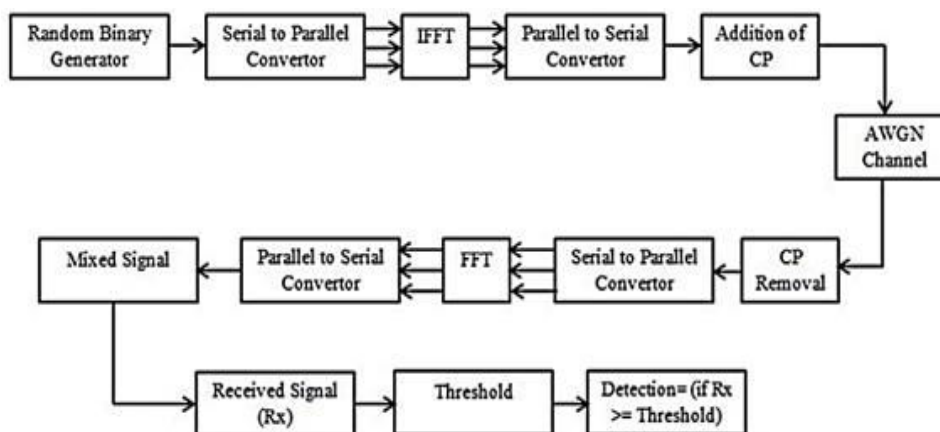


Fig. 2: Proposed MIMO-OFDM System using Matched Filter Detection Technique

Finally, the received signal is compared to a threshold value (λ) following the SNR or determines whether the signal is absent or present; if the received signal is greater than the threshold value, there will be detection, otherwise not:

$$\begin{aligned} S(t) &= n(t) & H_0 \\ S(t) &= \{h * P(t) + n(t)\} & H_1 \end{aligned}$$

Where $S(t)$ is the secondary user, $P(t)$ the primary user's transmitted signal, $n(t)$ is AWGN, h the amplitude gain of the channel, H_0 = there's no primary user, and H_1 = primary user is present.

V. CONCLUSION

The conventional spectrum sensing algorithms do not know how to deal with signals that use spread spectrum and time or frequency hopping codes. As a result, these types of signals constitute a major problem in sensing the spectrum. Hence, the sensing algorithms can be enhanced further so as to detect spread spectrum primary users. A matched filter, also known as optimal linear filter, is a spectrum-sensing method that detects the free portion of the primary user's spectrum and allocates it to secondary users. It derives from cross-correlating an unknown signal with known ones to detect the unknown signal's presence based on its SNR. In matched-filter detection, the dynamic threshold is used to improve the spectrum-sensing efficiency and provide better performance in cases of lower SNR.

REFERENCES

1. Arun Kumar, Nishant Gaur, Sumit Chakravarty, Mohammed H. Alsharif, Peerapong Uthansakul, Monthippa Uthansakul, "Analysis of spectrum sensing using deep learning algorithms: CNNs and RNNs", Ain Shams Engineering Journal, Elsevier 2024.
2. Kumar A, Venkatesh J, Gaur N, Alsharif MH, Jahid A, Raju K. Analysis of Hybrid Spectrum Sensing for 5G and 6G Waveforms. Electronics 2023;12(1):138.
3. Arun Kumar J, Venkatesh NG, Alsharif MH. Peerapong Uthansakul, Monthippa Uthansakul. Cyclostationary and energy detection spectrum sensing beyond 5G waveforms. Electron Res Arch 2023;31(6):3400–16.
4. Shen F, Wang Z, Ding G, Li K, Wu Q. 3D compressed spectrum mapping with sampling locations optimization in spectrum-heterogeneous environment. IEEE Trans Wirel Commun Jan. 2022;21(1):326–38.
5. Hamedani K, Liu L, Yi Y. Energy efficient MIMO-OFDM spectrum sensing using deep stacked spiking delayed feedback reservoir computing. IEEE Trans Green Commun Networking March 2021;5(1):484–96.
6. Arun Kumar and Nandha Kumar P, "OFDM system with cyclo-stationary feature detection spectrum sensing", Science Direct, Information Communication Technology, Express, Elsevier 22 January 2018 .
7. Abdullah Yaqot and Peter Adam Hoehner, "Efficient Resource Allocation in Cognitive Networks", IEEE Transactions on Vehicular Technology, Vol. 66, No. 07, July 2017.
8. Danda B. Rawat, "Evaluation Performance of Cognitive Radio Users in MIMO-OFDM based Wireless Networks", IEEE Transaction of Wireless System, Vol. 32, Issue 07, IEEE 2016.
9. Shan Jin and Xi Zhang, "Compressive Spectrum Sensing for MIMO-OFDM Based Cognitive Radio Networks", 2015 IEEE Wireless Communications and Networking Conference (WCNC), Applications, and Business, Vol. 27, No. 2, pp. 567-572, 2015.
10. Maan Singh and Vijay Kumar, "Investigation of PAPR Reduction in MIMO-OFDM System using PTS and SLM Techniques", International of Science and Research (IJSR), Vol. 3, No. 03, pp. 524-529, March 2014.
11. Muhammet Nuri Seyman and Necmi Taspamar, "Channel estimation based on neural network in space time block coded MIMO-OFDM system", Digital Signal Processing, Vol. 23, No.1, pp. 275-280, Jan. 2013.
12. Li Mei, Wang Xiang, Zhang Xiaoming, Jia Ke. "RLS and its improved algorithms in MIMO-OFDM System", International Journal of Modelling, Identification and Control, Vol. 16, No. 3, pp. 246-250, Jul. 2012.
13. P. Mukunthan and, P Dananjayan, "PAPR Reduction based on a Modified PTS with Interleaving and Pulse Shaping method for STBC MIMO-OFDM System", IEEE International Conference Coimbatore, July 2012.
14. Wei Jiang and Daoben Li, "Convolutional Multi-code Multiplexing for OFDM Systems", Beijing University of Posts and Telecommunications Beijing, pp. 6432-6439, IEEE 2012.
15. Yuan Jinsha, and Shi Hongmei, "A Modified Symbol Timing Synchronization Algorithm for WiMAX OFDM Systems", 2008 IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application.



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